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Elrod et al.

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(54) **HEALTH MONITORING SYSTEM FOR CAR SEAT**

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(73) Assignee: **The United States of America as represented by the Administrator of the National Aeronautics and Space Administration**, Washington, DC (US)

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(22) Filed: **Mar. 18, 2003**

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(52) **U.S. Cl.** **340/539.1**; 340/573.1; 701/45; 180/271; 280/735
(58) **Field of Search** 340/539.1, 539.15–573.1, 340/576, 438; 701/45; 180/271; 280/735

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,581,234	A		12/1996	Emery et al.	
5,618,056	A		4/1997	Schoos et al.	
5,678,854	A		10/1997	Meister et al.	
5,711,574	A		1/1998	Barnes	
5,790,031	A		8/1998	Shelton et al.	
5,838,233	A		11/1998	Hawes et al.	
5,851,026	A		12/1998	Schoos et al.	
5,912,624	A	*	6/1999	Howard, II	340/632
5,914,660	A	*	6/1999	Mesibov et al.	340/573.7
5,941,560	A		8/1999	Wolfram	
6,195,008	B1	*	2/2001	Bader	340/573.1
6,283,504	B1		9/2001	Stanley et al.	
6,304,179	B1		10/2001	Lotito et al.	
6,357,790	B1		3/2002	Swann et al.	
6,393,348	B1	*	5/2002	Ziegler et al.	701/45
6,402,240	B1		6/2002	Toba et al.	

* cited by examiner

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(57) **ABSTRACT**

A health monitoring system for use with a child car seat has sensors mounted in the seat to monitor one or more health conditions of the seat's occupant. A processor monitors the sensor's signals and generates status signals related to the monitored conditions. A transmitter wirelessly transmits the status signals to a remotely located receiver. A signaling device coupled to the receiver produces at least one sensory (e.g., visual, audible, tactile) output based on the status signals.

12 Claims, 4 Drawing Sheets

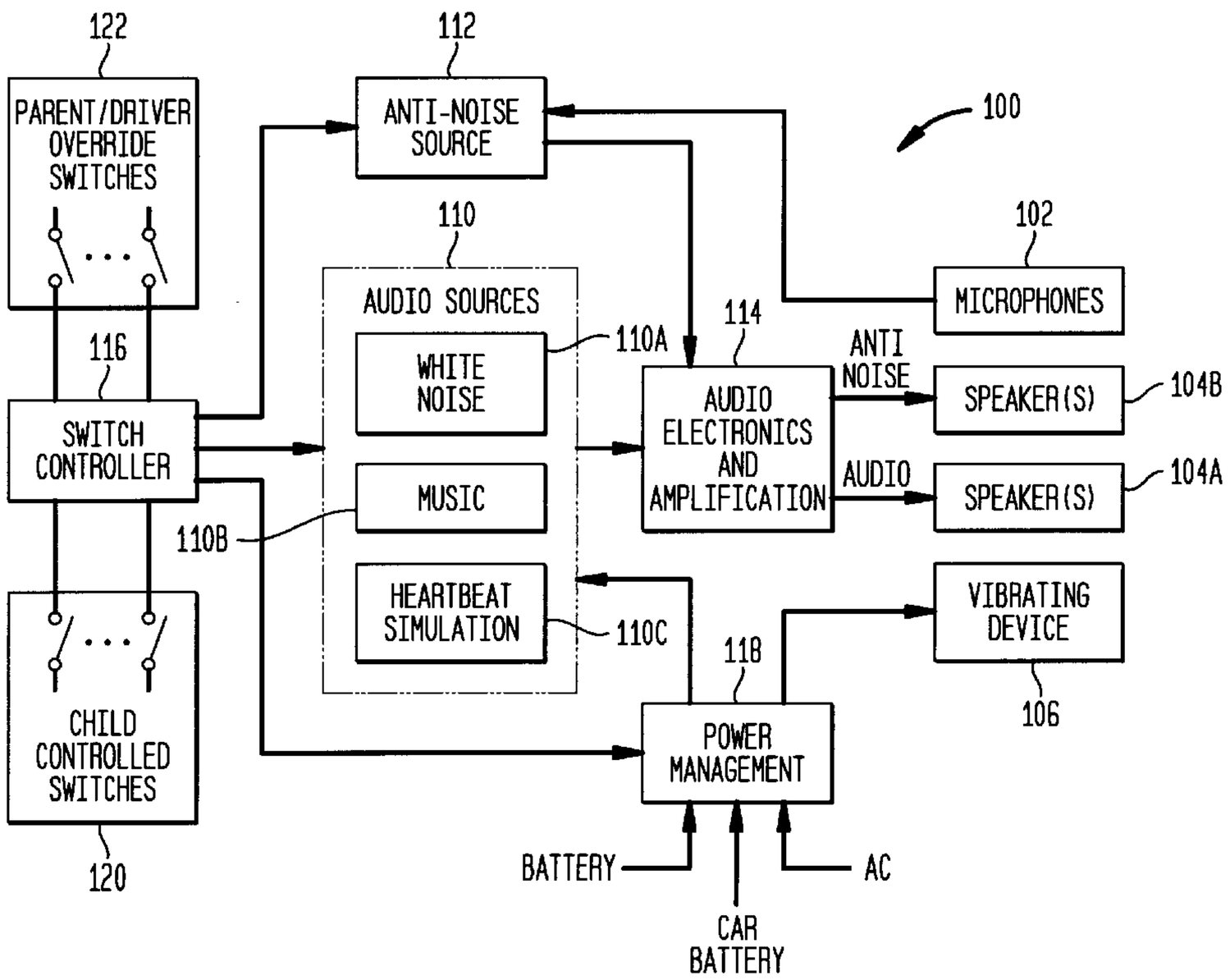


FIG. 1

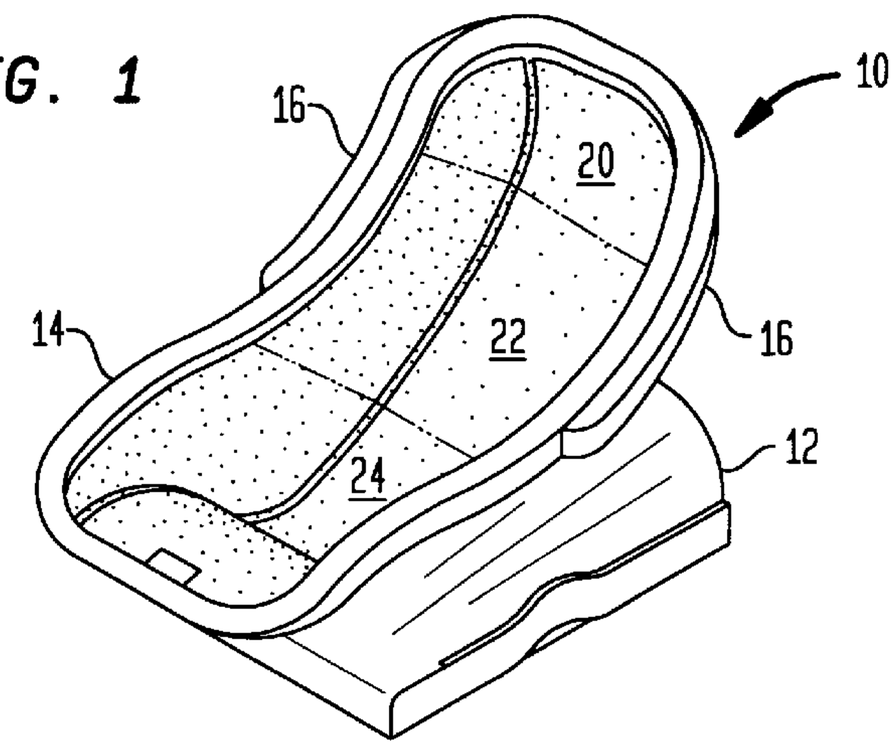

10
16
20
14
22
16
24
12

FIG. 2

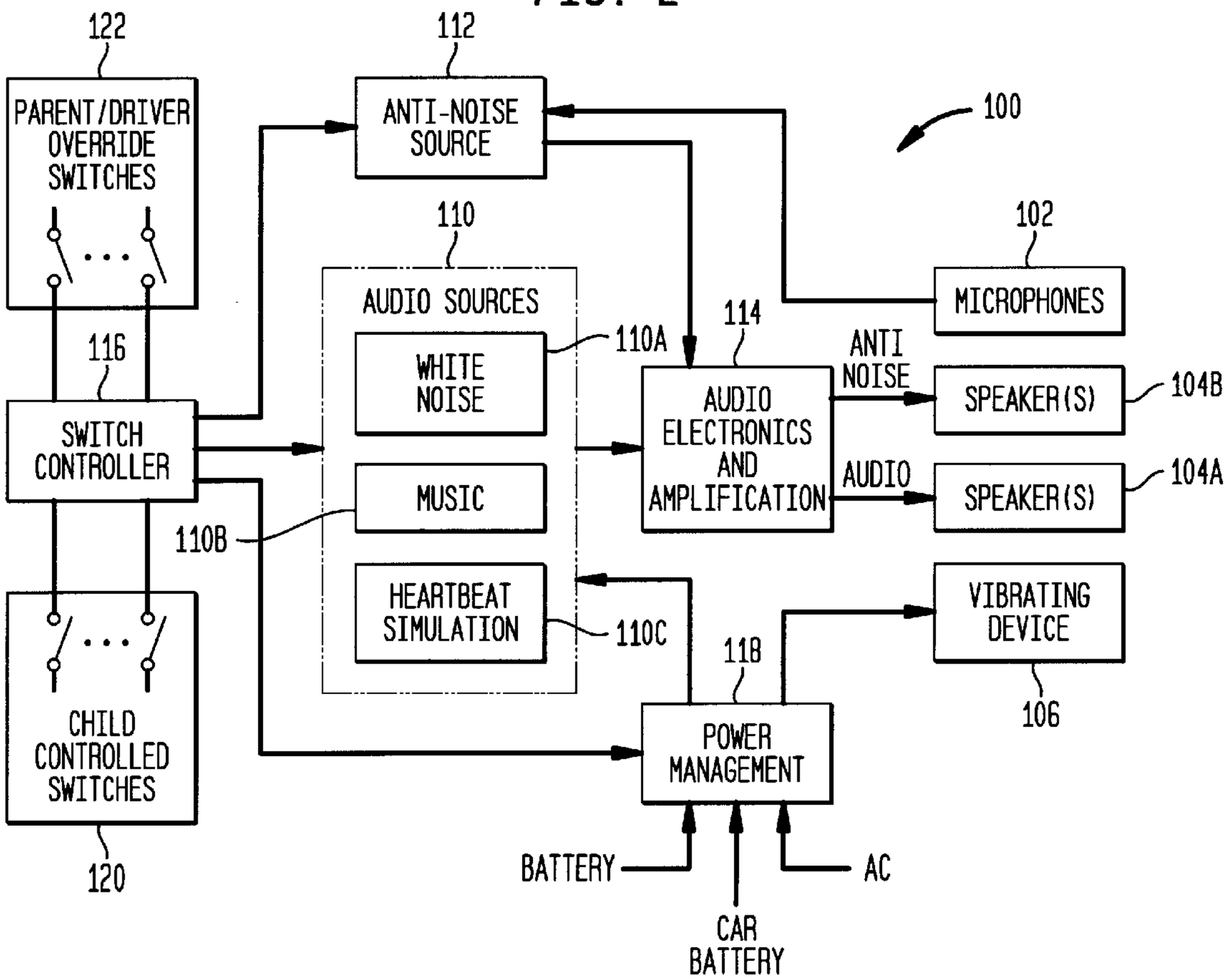

122
PARENT/DRIVER OVERRIDE SWITCHES
112
ANTI-NOISE SOURCE
100
110
AUDIO SOURCES
102
MICROPHONES
114
110A
WHITE NOISE
ANTI NOISE
SPEAKER(S)
104B
116
SWITCH CONTROLLER
AUDIO ELECTRONICS AND AMPLIFICATION
MUSIC
AUDIO
SPEAKER(S)
104A
110B
HEARTBEAT SIMULATION
110C
VIBRATING DEVICE
118
106
POWER MANAGEMENT
CHILD CONTROLLED SWITCHES
120
BATTERY
AC
CAR BATTERY

FIG. 3

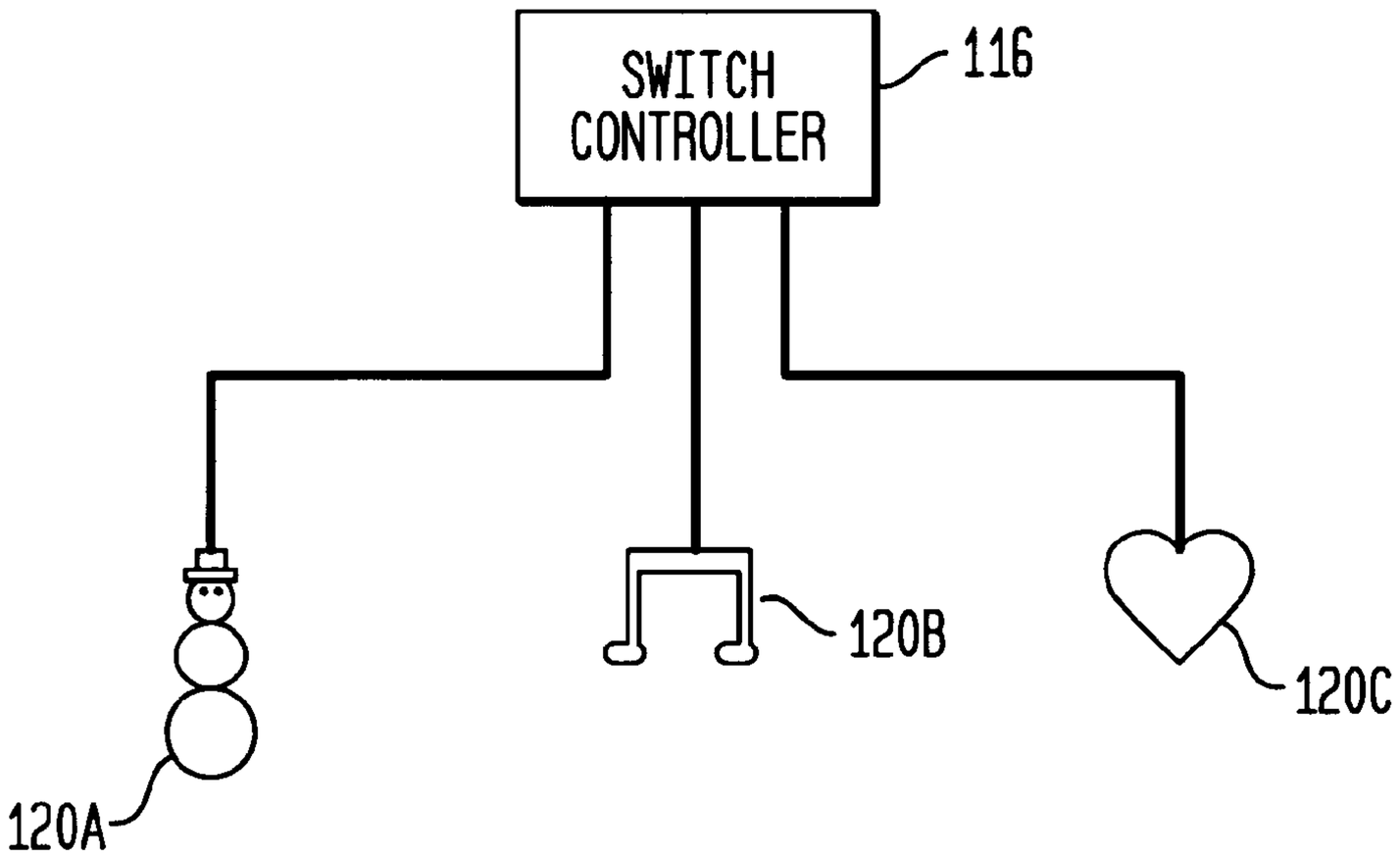

SWITCH CONTROLLER
116
120A
120B
120C

FIG. 4

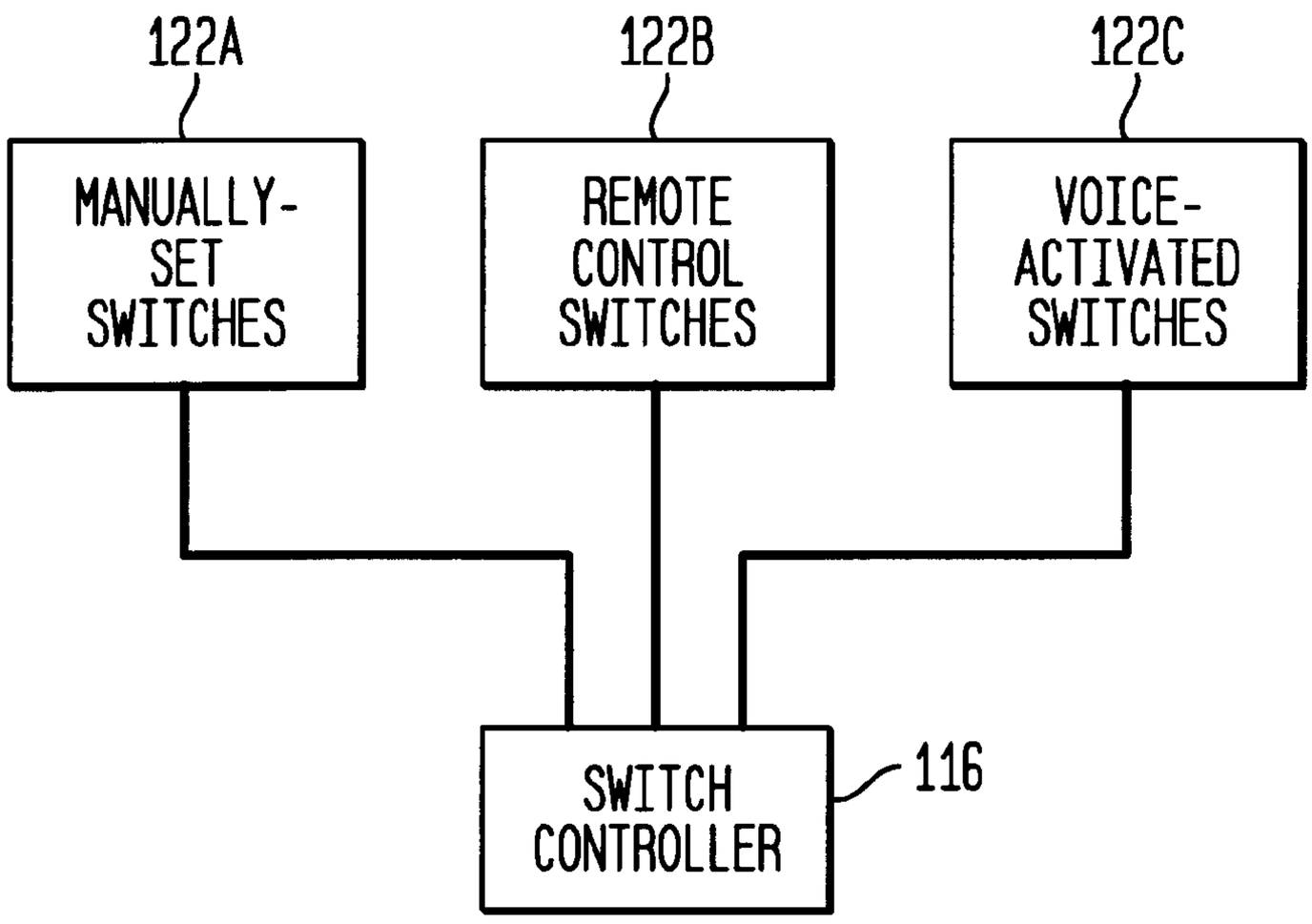

122A
122B
122C
MANUALLY-SET SWITCHES
REMOTE CONTROL SWITCHES
VOICE-ACTIVATED SWITCHES
SWITCH CONTROLLER
116

FIG. 5

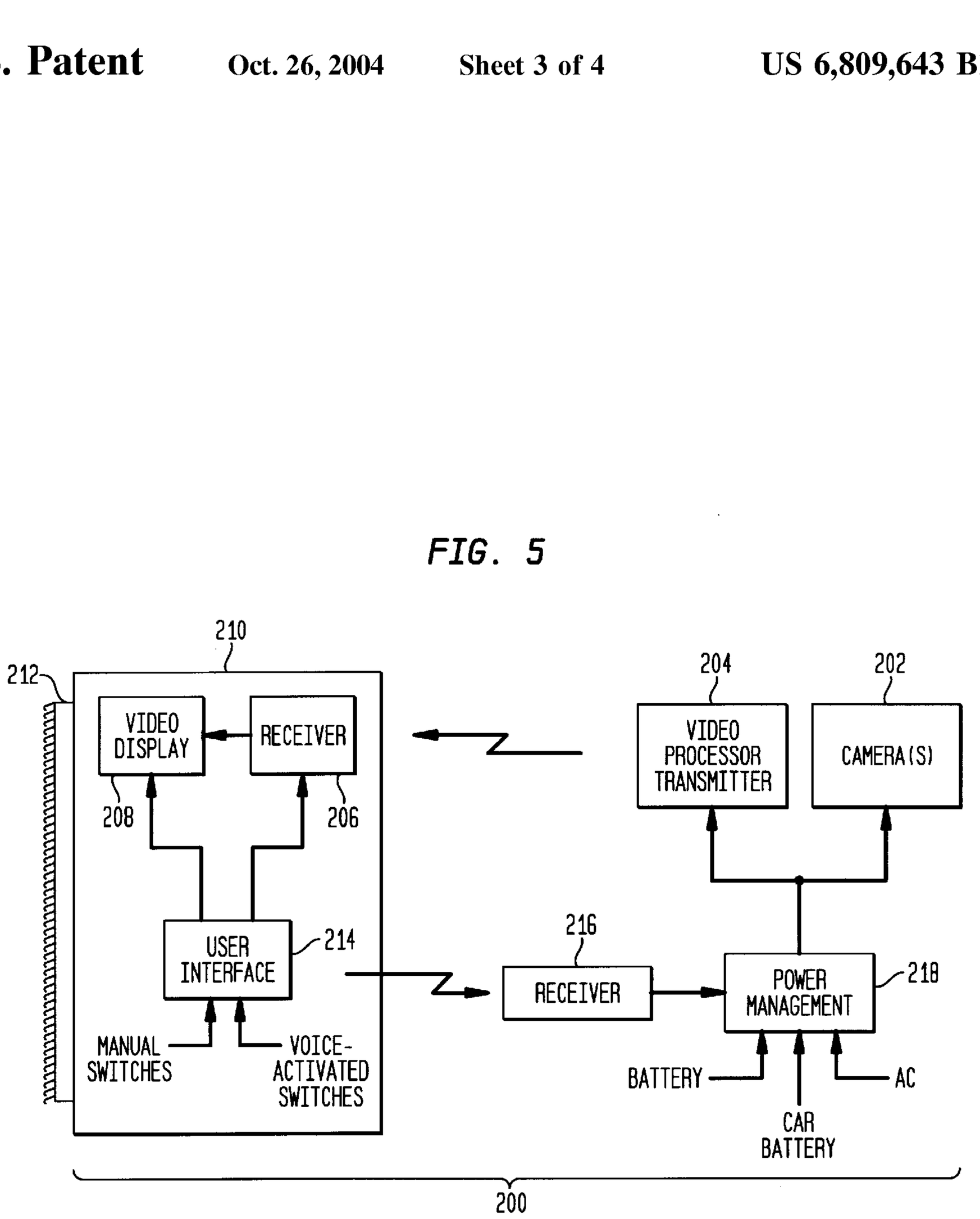
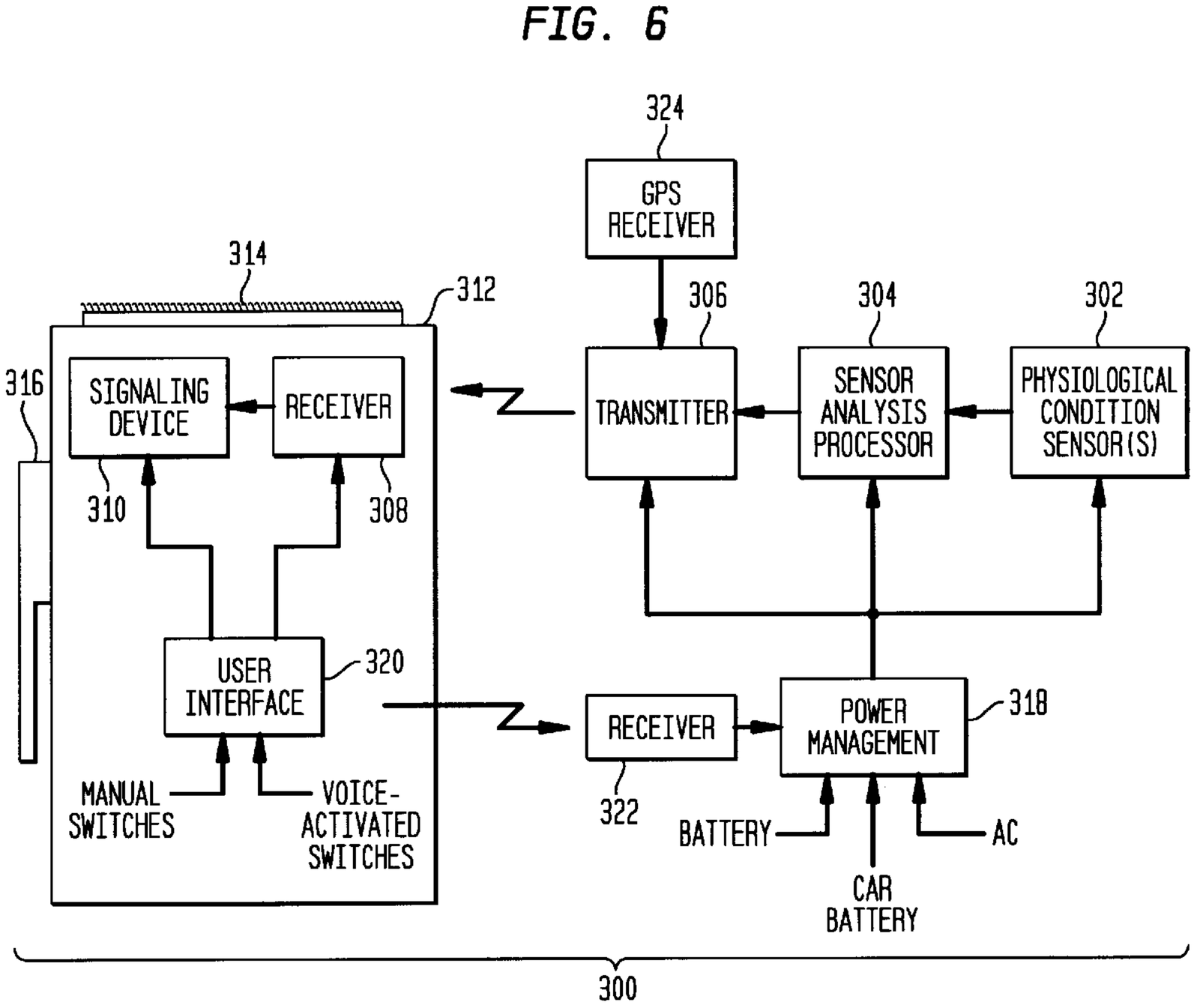

210
212
VIDEO DISPLAY
RECEIVER
208
206
USER INTERFACE
214
MANUAL SWITCHES
VOICE-ACTIVATED SWITCHES
204
202
VIDEO PROCESSOR TRANSMITTER
CAMERA(S)
216
RECEIVER
POWER MANAGEMENT
218
BATTERY
AC
CAR BATTERY
200

FIG. 6


324
GPS RECEIVER
314
312
306
304
302
316
SIGNALING DEVICE
RECEIVER
TRANSMITTER
SENSOR ANALYSIS PROCESSOR
PHYSIOLOGICAL CONDITION SENSOR(S)
310
308
USER INTERFACE
320
RECEIVER
POWER MANAGEMENT
318
MANUAL SWITCHES
VOICE-ACTIVATED SWITCHES
322
BATTERY
AC
CAR BATTERY
300

HEALTH MONITORING SYSTEM FOR CAR SEAT

ORIGIN OF THE INVENTION

The invention was made was made by employees of the United States Government and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to systems for monitoring a child in a car seat. More specifically, the invention is a system that uses sensors to monitor a variety of health indicators for an infant or child sitting in a car seat and then transmits the health indicators wirelessly to a remote signaling device.

2. Description of the Related Art

Parents today lead increasingly complex and demanding lives. For example, in two parent families, both parents frequently work for a variety of reasons ranging from the need to keep up with cost-of-living increases to the need for both parents to feel fulfilled on a business/professional level. The complexities and demands increase dramatically for single parents whose numbers have increased significantly over the last twenty years. However, along with managing business lives, all parents must also maintain a family life for their children. As a result of all of the above, infants and young children today spend a lot of time being driven around in the family vehicle. Whether it is going to and from daycare, running errands, or just the parent's desire to have their child with them, children today can spend several hours a week in a car.

Parents want to be sure their children are comfortable and safe while traveling. Further, there are laws mandating the use of child safety seats in vehicles. Thus, a variety of infant car seats currently on the market are designed to reduce the risk of injury in the event of a collision with another vehicle. However, none of today's car seats offer a parent the opportunity to monitor physiological conditions of the child in the car seat. This becomes important given the complexities of day-to-day life that may require parents to bring a sick child in the car. In addition, the medical profession's ability to diagnose many early childhood health conditions or concerns may make it desirable to frequently monitor a child. Such monitoring is not possible when traveling in a car.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a health monitoring system for use with a car seat.

Another object of the present invention to provide a system that can monitor a variety of physiological conditions of a child in a car seat and provide a sensory detectable signal when one or more of the physiological conditions may be of concern.

Other objects and advantages of the present invention will become more obvious hereinafter in the specification and drawings.

In accordance with the present invention, a health monitoring system is provided for use with a child car seat. Sensors are mounted in a child car seat to monitor an occupant sitting therein in terms of at least one of respiratory rate, heart rate and body temperature of the occupant. A processor mounted to the child car seat and coupled to the sensors monitors sensor signals and generates status signals related to at least one of respiratory rate, heart rate and body temperature of the occupant. A transmitter mounted to the child car seat and coupled to the processor wirelessly transmits the status signals to a remotely located receiver. A signaling device coupled to the receiver produces at least one sensory (e.g., visual, audible, tactile) output based on the status signals. The signaling device can be mounted in the vehicle in which the child car seat is installed or can be worn by the driver of the vehicle.

BRIEF DESCRIPTION OF THE DRAWING(S)

Other objects, features and advantages of the present invention will become apparent upon reference to the following description of the preferred embodiments and to the drawings, wherein corresponding reference characters indicate corresponding parts throughout the several views of the drawings and wherein:

FIG. **1** is a perspective view of a conventional child car seat;

FIG. **2** is a schematic view of an entertainment and pacification system of the present invention that is to be used with a child car seat;

FIG. **3** depicts squeezable toy switches that can be used by the child in the car seat to control the audio sources in the entertainment and pacification system;

FIG. **4** is a schematic view of possible types of parent/driver override switches that can be used in the present invention;

FIG. **5** is a schematic view of a video monitoring system that can be used to monitor a child in the car seat; and

FIG. **6** is a schematic view of a health monitoring system that can be used to monitor a child in the car seat.

DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

Referring now to the drawings, and more particularly to FIG. **1**, a conventional child car seat is shown and referenced generally by numeral **10**. Car seat **10** is representative of a well known car seat design having a base **12** that is typically attached to a vehicle's seat by means of a vehicle seat belt (not shown). A removable seat **14** is locked/unlocked to base **12** with the locking and unlocking operation typically controlled by means of a pull down handle **16** shown in its upright (locked) position. Handle **16** is pivoted over seat **14** to unlock same from base **12** and serve as a carrying handle for seat **14**. Car seat **10** is generally used for newborns and children up to about 2 years old depending on their size and weight. Car seat **10** is designed to face rearward in a vehicle for very young children and forward when they are a little older.

It is to be understood that the present invention is in no way limited by the design of car seat **10** and that the present invention can be incorporated into any type of car seat (e.g., one piece, two piece as just described, etc.). However, since parental concerns about a child's welfare are most heightened when the child is very young (i.e., 0 to 2 years old), and since the very young child can be uncontrollably loud or fussy when they are uncomfortable, the description of the present invention will be referenced to car seat **10**.

Referring additionally now to FIG. **2**, an entertainment and pacification (E/P) system that it is to be used with car seat **10** is shown and referenced generally by numeral **100**. E/P system **100** includes components that must be mounted in/on seat **14**, components that can be mounted on or

coupled to either of seat **14** or base **12**, and components that must be located remotely with respect to car seat **10**. Such mounting and location will be described in detail below.

With respect to components mounted in/on seat **14**, one or more microphones **102** are fitted in/on seat **14** near the seat's headrest area designated by area **20** in FIG. **1**. For reasons that will be explained further below, at least two audio speakers **104**A and **104**B are fitted into or on headrest area **20**. The particular placement of microphone(s) **102** and speakers **104**A and **104**B in headrest area **20** is not a limitation of the present invention. An electro-mechanical vibrating device **106** can optionally be provided and coupled to either back area **22** or seat area **24** (FIG. **1**) of seat **14**. When activated, vibrating device **106** introduces vibrational waves into seat **14** thereby making seat **14** vibrate in a massaging or soothing fashion. Such massage may pacify the child in seat **14**. Again, the particular placement of such vibrating device **106** is not a limitation of the present invention. Also mounted on seat **14** are a plurality of child-controlled switches **120** which will be explained further below.

Mounted to either base **12** or seat **14** are the components for controlling speakers **104**A/**104**B and vibrating device **106**, and for receiving/using the outputs generated by microphone(s) **102**. The components mounted in base **12** (or mounted to seat **14**) include a plurality of audio sources **110**, an anti-noise source **112**, an audio electronics and amplification module **114**, a switch controller **116**, and a power management module **118**. The advantage of mounting these components on seat **14** is that E/P system **100** can be utilized even when seat **14** is not mounted to base **12**. The disadvantage is the weight that these components add to seat **14**. Thus, if weight is a concern, it may be desirable to mount some or all of these components in base **12**. However, this requires the use of connectors that would allow the coupling of these components to microphone(s) **102**, speakers **104**A/**104**B and vibrating device **106**. Such connectors would ideally be automatically coupled upon the locking of seat **14** to base **12**.

Audio sources **110** can include, for example, a white noise generator **110**A, a music generator **110**B and a human heartbeat simulation generator **110**C. Each of these types of audio sources are well known in the art and can be realized in a variety of ways. For example, music generator **110**B can be any one of a variety of digital type devices to include an MP3 player, a CD player, etc. White noise generator **110**A can be used to generate a white noise signal having a spectral frequency distribution that is tuned/filtered to produce an audio output that is calming to the child in seat **14**. Human heartbeat simulation generator **110**C produces an audio signal that, when amplified, produced an audio output simulating a human heartbeat.

When activated, the audio signal produced by each of these sources can be filtered and amplified as needed by audio electronics and amplification module **114** before being supplied to at least one of speakers **104**A. At any given time, only one of audio sources **110** is activated by switch controller **116** with the generated audio signal being reproduced at speakers **104**A. Power for the selected one of audio sources **110** is supplied by power management module **118** which will be described later below.

Anti-noise source **112** is an active ambient noise suppression system that uses the output of microphone(s) **102** (i.e., the ambient noise detected in headrest area **20**) to generate a (canceling) audio signal that is equal in magnitude but opposite in phase to the detected ambient noise. Such anti-noise suppression systems are well known in the art of broadcasting and airline pilot headsets. The anti-noise or canceling audio signal is filtered/amplified at module **114** before being reproduced at one or more of speakers **104**B. Thus, at any given time, speakers **104**A are dedicated to one of audio sources **110** while speakers **104**B are dedicated to anti-noise source **112**. Alternatively, the canceling audio signal (from source **112**) can be blended with the audio signal (from a selected source **110**) and fed to any or all of speakers **104**A and **104**B. In either case, the selected one of audio sources **110** is played in an environment (i.e., headrest area **20**) that is free from outside ambient noise which can distract and/or overstimulate the child in seat **14**. Note that since it is desired to cancel outside ambient noise (e.g., car noise, road noise, traffic noise, passenger conversation noise, etc.) while maintaining the audio produced by one of audio sources **110**, microphone(s) **102** mounted in headrest area **20** may be directionally focused to detect ambient noise without detecting that generated by the selected one of audio sources **110**.

As previously mentioned, switch controller **116** is used to select which of audio sources **110** is activated, whether or not anti-noise source **112** is activated and, if included, whether or not vibrating device **106** is activated. Switch inputs can be provided the child in seat **14** by means of a plurality of manually-operated switches **120**. For example, in the illustrated example, switches controlling audio sources **110** can be realized by squeezable bulb switches **120**A, **120**B and **120**C that are in the shape of toy figures as illustrated in FIG. **3**. Specifically, switch **120**A in the, shape of a snowman is used to activate white noise generator **110**, switch **120**B in the shape of a musical note is used to activate music generator **110**B, and switch **120**C in the shape of a heart is used to activate human heartbeat simulation generator **110**C. Additional toy switches would be provided for anti-noise source **112** and vibrating device **106**.

Since some very young children may either not have the dexterity to work switches **120** or may become frustrated at not being able to get what they want, a second set of parent/driver controlled override switches **122** are also coupled to switch controller **116**. Selection made at override switches **122** will take priority over any selections made by the child using switches **120**. Switches **122** would typically be located remotely with respect to child car seat **10**. Preferably; switches **122** are positioned such that a driver can make selections while driving.

Override switches **122** allow the parent/driver to select the particular one of audio sources **110** that keeps the child satisfied. Additionally or alternatively, override switches **122** allow the parent/driver to activate/deactivate anti-noise source **112** as needed and/or activate/deactivate vibrating device **106** as needed. As shown in FIG. **4**, switches **122** could be manually-set switches **122**A that are beyond the child's reach, remote control (e.g., an infrared or RF remote) switches **122**B or voice-activated switches **122**C. If either remote control switches **122**B or voice-activated switches **122**C are wireless-based, a wireless receiver **124** is coupled to switch controller **116**.

Power management module **118** supplies power to components of E/P system **100** that are mounted on/in car seat **10**. Such power can come "locally" from an onboard battery, or can come from a remotely located source such as the vehicle's battery (via the vehicle's cigarette lighter) or a standard 120 VAC source if E/P system **100** is to be used in a house or other building. Accordingly, power management module **118** typically includes means for receiving an outside power source (e.g., ports) and monitoring the particular

source of power and converting/filtering/amplifying it to satisfy the requirements of the components of E/P system **100**. Such power management controllers are well known in the art.

In operation, with a child in seat **14**, the child can select one of audio sources **110**, and the independent activation/deactivation of each of anti-noise source **112** and vibrating device **106**. Provided the child is content with his/her choices, the parent/driver need not use override switches **122**. However if the child is dissatisfied or unable to make selections, the parent/driver makes override selections using switches **122**.

In addition to or as an alternative to E/P system **100**, car seat **10** can be equipped with a video monitoring system **200** illustrated schematically in FIG. **5**. Video monitoring system **200** includes components mounted in/on car seat **10** as well as components located remotely with respect to car seat **10**. Mounted in or on seat **14** are one or more miniature video cameras **202** that can be mounted in headrest area **20** and/or on pull down handle **16** (FIG. **1**). One or more of camera(s) **202** can be an infrared camera thereby allowing their use in low light or dark conditions without visible illumination which might disturb the child and/or distract the driver. If necessary, an infrared illuminator (not shown) can be included to insure satisfactory illumination regardless of ambient lighting conditions without disturbing the occupant of the car seat.

When activated, the video signal generated by camera(s) **202** is processed and transmitted wirelessly by means of a video processor/transmitter **204**. Power for camera(s) **202** and processor/transmitter **204** can be supplied by a power management module **218** which is identical in concept to power management module **118**. Accordingly, module **218** will not be discussed further herein.

Components located remotely with respect to car seat **10** include a wireless receiver **206** and a video display **208**. Receiver **206** detects the transmitted video signals and presents same to video display **208** (e.g., an LCD or other lightweight display). Preferably, receiver **206** and video display **208** are encased in a portable housing **210** which can be easily placed/mounted in the front seat area of the vehicle in which car seat **10** is installed. For example, housing **210** could simply have a hook-and-loop fastening strip **212** coupled thereto for mating with a complementary strip (not shown) positioned where desired in the vehicle. The portable nature of housing **210** and its components allows system **200** to function in venues other than a vehicle when seat **14** is removed therefrom.

Activation and control of camera(s) **202**, transmitter **204**, receiver **206** and video display **208** can be provided by a user interface **214** which can be incorporated into housing **210**. User interface **214** can include remote control features that issue wireless remote control signals to a receiver **216** at car seat **10** which can instruct power management module **218** to power the appropriate components. Such control signals are provided by the parent/driver using manually-generated switches and/or voice-activated switches supported by user interface **214**.

In addition to, or as an alternative to E/P system **100** and/or video monitoring system **200**, car seat **10** can be equipped with a health monitoring system **300** which is illustrated schematically in FIG. **6**. As with the above-described features, health monitoring system **300** includes components in/on car seat **10** as well as components located remotely with respect to car seat **10**. More specifically, mounted in or on seat **14** are one or more physiological condition sensor(s) **302**, a sensor analysis processor **304**, a transmitter **306** and a power management module **318** which is identical in concept to power management module **118**. With respect to sensor(s) **302**, their particular mounting location depends on the type of sensor(s) and the condition being monitored. For example, in terms of a child's respiratory rate and heart rate, sensor(s) **302** could be one or more microphones located in the upper portion of back area **22** illustrated in FIG. **1**. That is, such microphones would function much like a doctor's stethoscope pick-up head. Sensor(s) **302** could also include sensor(s) for measuring body temperature such as an infrared thermometer or pyrometer mounted, preferably, in headrest area **20** since such sensors need to access exposed skin, i.e., the child's face.

Sensor(s) **302** provide their sensed outputs to sensor analysis processor **304** where the sensed signals are compared with either known normal/abnormal levels or ranges thereof. For example, processor **304** might be programmed with acceptable/unacceptable thresholds or ranges for respiratory rates, heart rates and body temperatures. Note that these thresholds could be set to standard levels or specific levels if a child had special needs or concerns.

The results of the comparisons made a processor **304** would be used to generate a status signal which could be an actual reading, an "OK" or "not OK" status, or simply generate an alarm type of status signal only when a "not OK" condition exists. The status signals are passed to wireless transmitter **306** which transmits same over the air waves. Power for each of sensor(s) **302** (if needed), processor **304** and transmitter **306** can be supplied by power management module **318**.

Components located remotely with respect to car seat **10** include a wireless receiver **308** and a signaling device **310**. Receiver **308** detects the transmitted status signals and presents same to signaling device **310** which produces one or more outputs that can be easily monitored by the parent/driver. Accordingly, such outputs can be audible, visual or tactile in nature (e.g., vibration). Preferably, receiver **308** and signaling device **310** are encased in a portable housing **312** which can either be placed/mounted in the vehicle or worn on the parent/driver's clothing. For example, housing **312** can have a hook-and-loop fastening strip **314** coupled thereto and/or a belt clip **316** coupled thereto. The portable nature of housing **312** and its components allows system **300** to function in venues other than a vehicle when seat **14** is removed therefrom.

Activation and control of sensor(s) **302**, processor **304**, transmitter **306**, receiver **308** and signaling device **310** can be provided by a user interface **320** which can be incorporated into housing **312**. User interface **320** can include remote control features that issue wireless remote control signals to a receiver **322** at car seat **10** which can then pass such instructions to power management module **318** to power the appropriate components. Such control signals are provided by the parent/driver using manually-operated switches and/or voice activated switches.

Health monitoring system **300** can also include a tracking feature to allow the whereabouts of seat **14** to be monitored. Such tracking could be provided by GPS position signals received at a GPS receiver **324** mounted to seat **14**. The GPS position signals could be passed to transmitter **306** for transmission over the airwaves.

The advantages of the present invention are numerous. A child in a car seat can now be entertained, pacified, monitored visually and/or monitored in terms of biological vital

signs. All of the features can be controlled/monitored by the parent/driver without ever having to turn around and look into the back seat of the vehicle. Thus, the present invention provides a new level of vehicle safety for everyone on the road.

Although the invention has been described relative to a specific embodiment thereof, there are numerous variations and modifications that will be readily apparent to those skilled in the art in light of the above teachings. It is therefore to be understood that, within the scope of the appended claims, the invention may be practiced other than as specifically described.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A health monitoring system for use with a child car seat, comprising:

sensors mounted in a child car seat for monitoring an occupant sitting therein in terms of at least one of respiratory rate, heart rate and body temperature of the occupant, and for generating signals indicative thereof;

a processor mounted to the child car seat and coupled to said sensors for monitoring said signals and for generating status signals related to at least one of respiratory rate, heart rate and body temperature of the occupant;

a transmitter mounted to the child car seat and coupled to said processor for wirelessly transmitting said status signals;

means for remotely controlling activation of said sensors, said processor and said transmitter;

a receiver located remotely with respect to the child car seat for receiving said status signals so-transmitted; and

a signaling device coupled to said receiver for producing at least one sensory output based on said status signals, said at least one sensory output selected from the group consisting of visual, audible and tactile outputs.

2. A health monitoring system as in claim **1** wherein said means for remotely controlling is voice activated.

3. A health monitoring system as in claim **1** wherein said signaling device includes means for facilitating mounting of same in a vehicle in which the child car seat is installed.

4. A health monitoring system as in claim **1** wherein said signaling device includes means for attaching same to an article of clothing.

5. A health monitoring system as in claim **1** further comprising a GPS receiver mounted to the child car seat for sensing a position of the child car seat and for generating a position signal indicative thereof, said GPS receiver coupled to said transmitter wherein said position signal is transmitted wirelessly therefrom.

6. A health monitoring system as in claim **1** wherein said processor is programmed with at least one threshold level of respiratory rate, heart rate and body temperature, and wherein said status signals are based on relationships between said signals so-monitored and said at least one threshold.

7. A health monitoring system for use with a child car seat, comprising:

sensors mounted in a child car seat for monitoring an occupant sitting therein in terms of at least one of respiratory rate, heart rate and body temperature of the occupant, and for generating signals indicative thereof;

a processor mounted to the child car seat and coupled to said sensors for monitoring said signals and for generating status signals related to at least one of respiratory rate, heart rate and body temperature of the occupant;

a transmitter mounted to the child car seat and coupled to said processor for wirelessly transmitting said status signals;

means for remotely controlling activation of said sensors, said processor and said transmitter;

power management means mounted on the child car seat and coupled to said sensors, said processor and said transmitter for supplying power thereto, said power management means including a rechargeable battery serving as a local source of said power and at least one port for receiving said power from a remotely-located source of said power;

a receiver located remotely with respect to the child car seat for receiving said status signals so-transmitted; and

a signaling device coupled to said receiver for producing at least one sensory output based on said status signals, said at least one sensory output selected from the group consisting of visual, audible and tactile outputs.

8. A health monitoring system as in claim **7** wherein said means for remotely controlling is voice activated.

9. A health monitoring system as in claim **7** wherein said signaling device includes means for facilitating mounting of same in a vehicle in which the child car seat is installed.

10. A health monitoring system as in claim **7** wherein said signaling device includes means for attaching same to an article of clothing.

11. A health monitoring system as in claim **7** further comprising a GPS receiver mounted to the child car seat for sensing a position of the child car seat and for generating a position signal indicative thereof, said GPS receiver coupled to said transmitter wherein said position signal is transmitted wirelessly therefrom.

12. A health monitoring system as in claim **7** wherein said processor is programmed with at least one threshold level of respiratory rate, heart rate and body temperature, and wherein said status signals are based on relationships between said signals so-monitored and said at least one threshold.

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